



# **The NASA Electronic Parts and Packaging (NEPP) Program – Overview for FY14**

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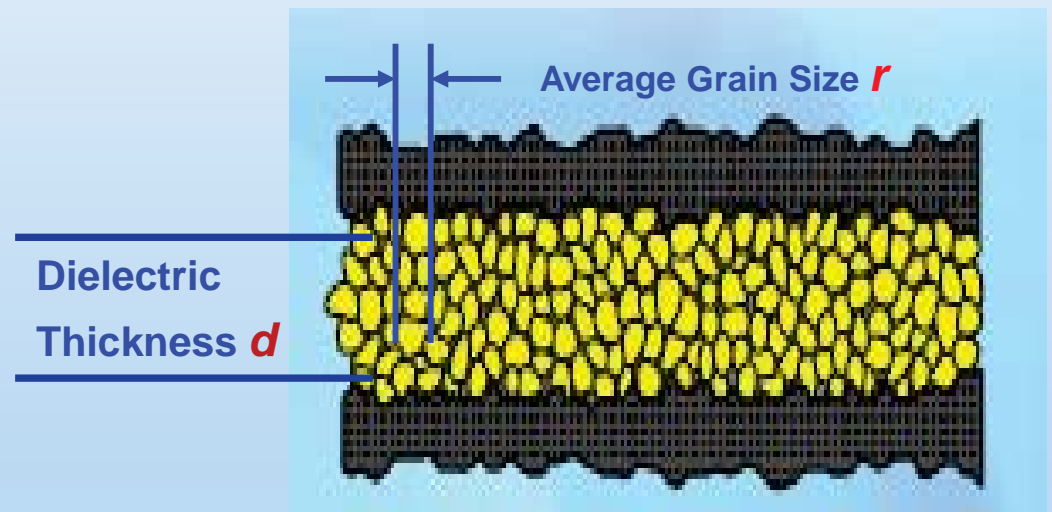
**<http://nepp.nasa.gov>**

***Unclassified***



# Outline

- Acronym List
- Overview of NEPP
  - What We Do and Who We Are
  - Working with Others
- Plans for FY14
- Recent Highlights
- Parts “Graveyard”
- Summary



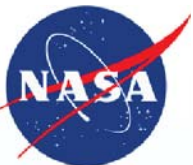
**Multi-Layer Ceramic Capacitor (MLCC)**



# Acronyms (1)

Acronym	Definition
3D	Three Dimensional
ADC	Analog to Digital Converter
Aero	Aerospace
AFRL	Air Force Research Laboratory
AFSMC	Air Force Space and Missiles Center
AMRDEC	Aviation and Missile Research Development and Engineering Center
ARC	Ames Research Center
ASU	Arizona State University
AVSI	Aerospace Vehicle Systems Institute
BME	Base Metal Electrode
BOK	Body of Knowledge
CALCE	Center for Advanced Life Cycle Engineering
CAVE	Center for Advanced Vehicle and Extreme Environment Electronics
CBRAM	Conductive Bridging Random Access Memory
CMOS	Complementary Metal Oxide Semiconductor
CNES	Centre National d'Etudes Spatiales
COP	Community of Practice
COTS	Commercial Off The Shelf
CSA	Canadian Space Agency
DAC	Digital to Analog Converter
DARPA	Defense Advanced Research Projects Agency
DC	Direct Current
DDR	Double Data Rate
DLA/DSCC	Defense Logistics Agency Land and Maritime
DMEA	Defense Microelectronics Activity
DTRA	Defense Threat Reduction Agency

Acronym	Definition
EEE	Electrical, Electronic, and Electromechanical
ELDRS	Enhanced Low Dose Rate Sensitivity
EPARTS	NASA Electronic Parts Database
ESA	European Space Agency
ETW	Electronics Technology Workshop
FPGA	Field Programmable Gate Array
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FY	Fiscal Year
G11	Component Parts Committee
G12	Solid State Devices Committee
GaAs	Gallium Arsenide
GaN	Gallium Nitride
GIDEP	Government Industry Data Exchange Program
GRC	Glenn Research Center
GSFC	Goddard Space Flight Center
HALT	Highly Accelerated Life Test
HiREV	High Reliability Virtual Electronics Center
IARPA	Intelligence Advanced Research Projects Agency
IBM	International Business Machines
ICBM	Intercontinental Ballistic Missile
IP	Intellectual Property
IPC	(not an acronym)
JAXA	Japanese Space Agency
JEDEC	Joint Electron Device Engineering Council
JHU-APL	Johns Hopkins University Applied Physics Laboratory



# Acronyms (2)

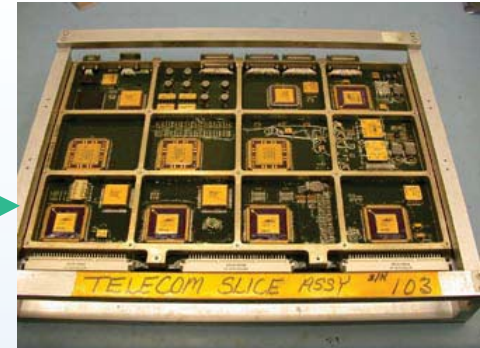
Acronym	Definition
JPL	Jet Propulsion Laboratories
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
LEAP	Leading Edge Access Program
MDA	Missile Defense Agency
MEMS	Microelectromechanical Structure
MIL	Military
MLCC	Multi-Layer Ceramic Capacitor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MRQW	Microelectronics Reliability and Qualification Working Meeting
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NAVSEA	Naval Sea Systems Command
NEPAG	NASA Electronic Parts Assurance Group
NEPP	NASA Electronic Parts and Packaging
NGC	Northrop Grumman Corporation
NPSL	NASA Parts Selection List
NRL	Naval Research Laboratory
NRO	National Reconnaissance Office
NSP	National Space Programs
NSWC	Naval Surface Warfare Center
PBGA	Plastic Ball Grid Array

Acronym	Definition
PCB	Printed Circuit Board
POC	Point of Contact
POF	Physics of Failure
POL	Point of Load
QML	Qualified Manufacturer List
RERAM	Resistive Random Access Memory
RF	Radio Frequency
SAE	Society of Automotive Engineers
SAS	Supplier Assessment System
SEU	Single Event Upset
SiC	Silicon Carbide
SMC	Space and Missile Command
SNL	Sandia National Laboratories
SOC	Systems on a Chip
SST	Silicon Space Technologies
STS	Silicon Turnkey Solutions
SW	Southwest
SwRI	Southwest Research Institute
TI	Texas Instruments
TMR	Triple Modular Redundancy
TRL	Technology Readiness Level
US	United States
USAF	United States Air Force
USASMD	United States Army Space and Missile Defense Command
USN	United States Navy
VCS	Voluntary Consensus Standards
VNAND	Vertical NAND



# NEPP - Frame of Reference

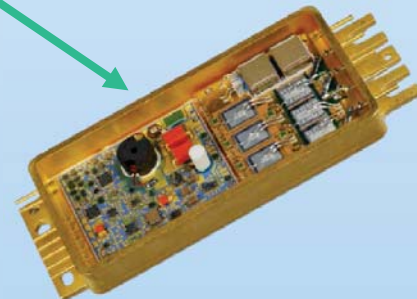
- **EEE (electrical, electronic, and electromechanical) parts are:**
  - All the things that are on printed circuit boards (PCB) inside of electronics boxes.
- **This includes:**
  - Integrated Circuits (ICs or chips) like processors and memories as well as passives such as capacitors and resistors,
  - Hybrid devices or multi-chip modules: Small packages that house multiple chips internally that are placed on the PCB, and,
  - Connectors and wires used to send electrical or power signals between boards, boxes, or systems.
- **This does not include:**
  - The PCB - NASA Workmanship Program responsibility.



PCB from Mars Rover  
*Image courtesy NASA*



*Image courtesy BAE Systems*



*Image courtesy NASA*



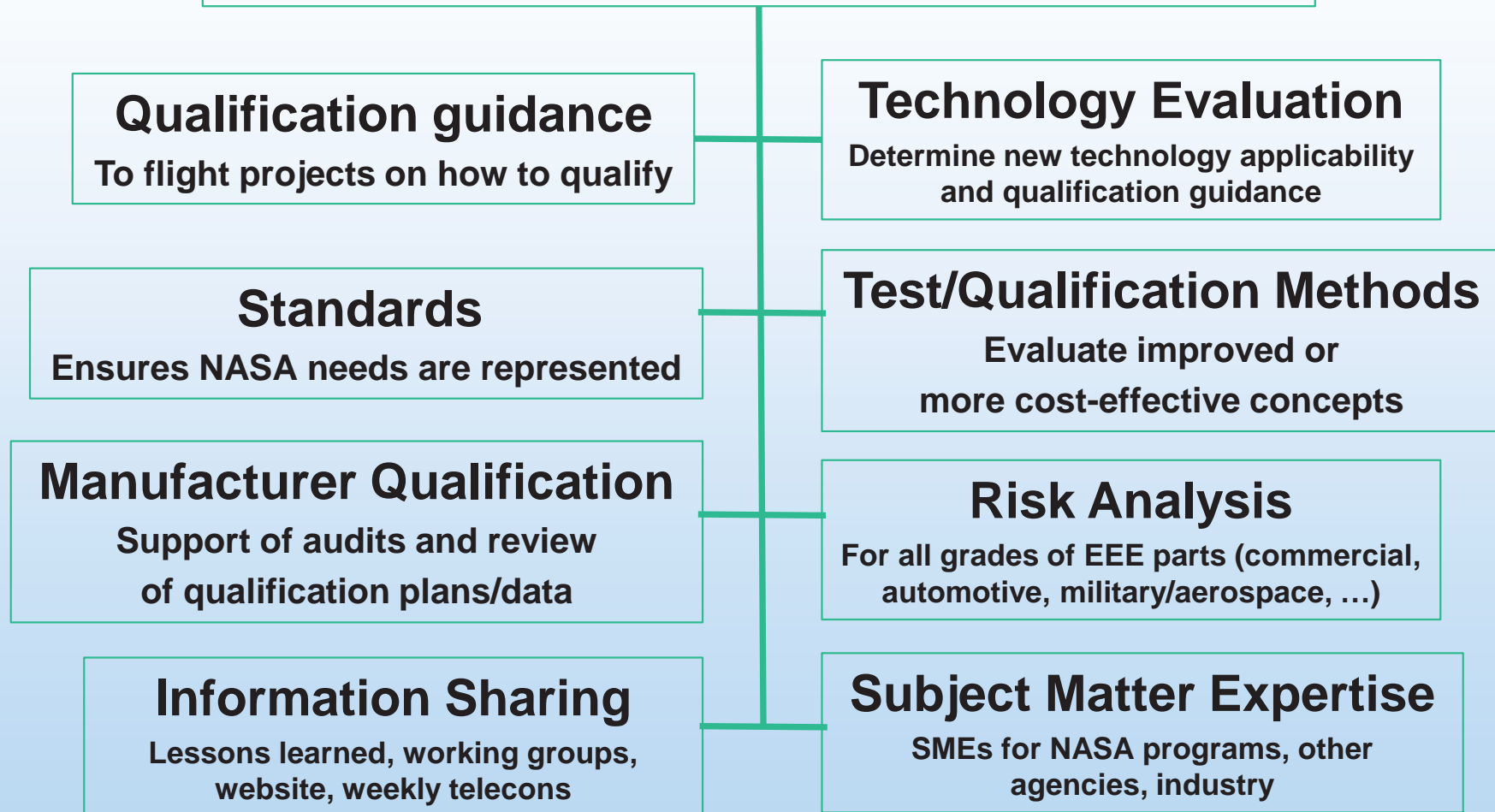
# EEE Parts and Space

- **EEE parts are available in “grades”**
  - Designed and tested for specific environmental characteristics.
    - E.g., Operating temperature range, vacuum, radiation exposure,...
  - Examples: Aerospace, Military, Automotive, Medical, Extended-Temperature-Commercial, and Commercial.
- **Aerospace Grade is the traditional choice for space usage, but has relatively few available parts and their performance lags behind commercial counterparts (speed, power).**
  - Designed and tested for radiation and reliability for space usage.
- **NASA uses a wide range of EEE part grades depending on many factors (technical, programmatic, and risk).**
  - ***NEPP is the Agency’s independent view for understanding “safe” usage.***



# NEPP Overview

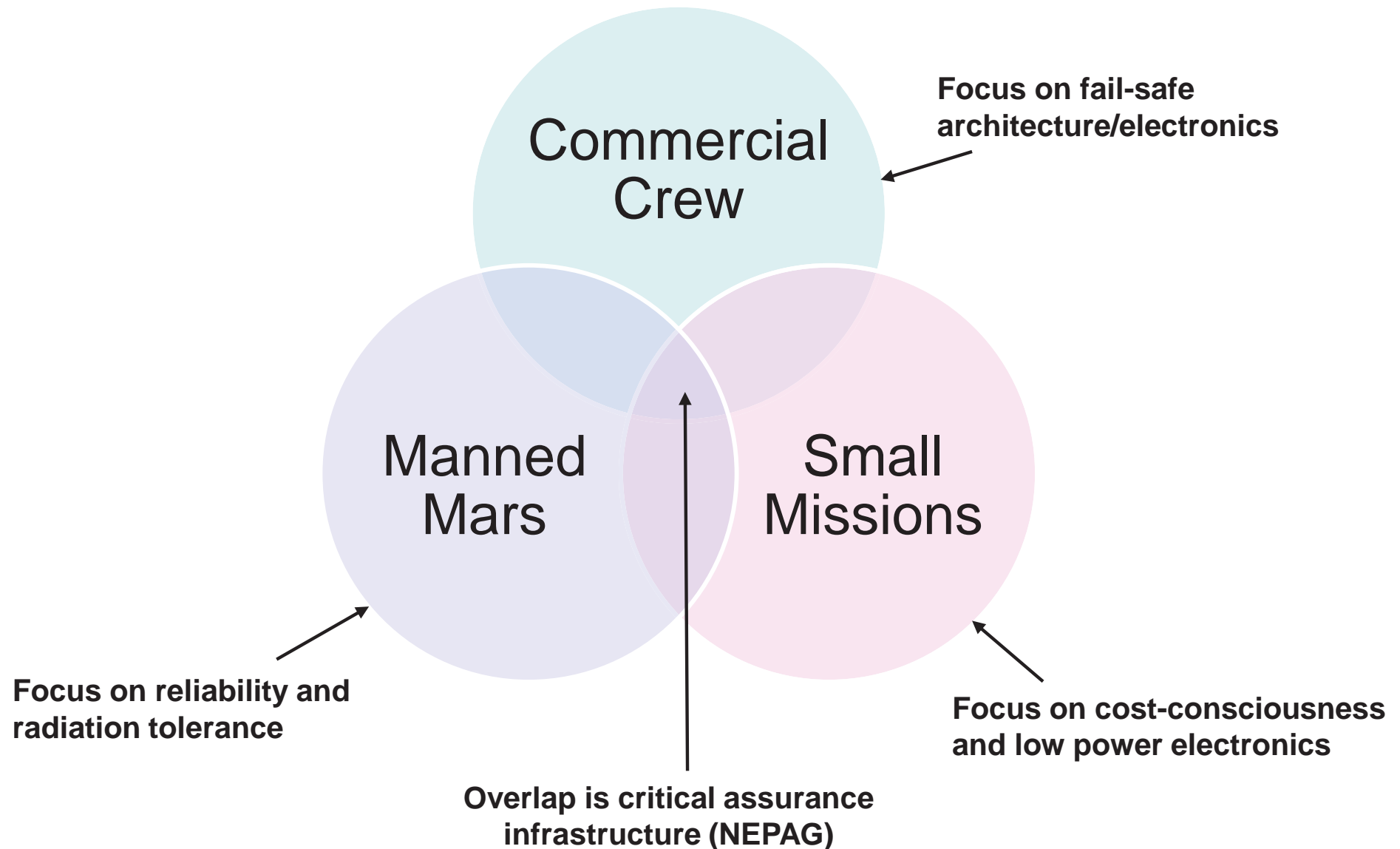
***NEPP provides the Agency infrastructure for assurance of EEE parts for space usage.***



***NEPP and its subset (NASA Electronic Parts Assurance Group – NEPAG) are the Agency's POCs for reliability and radiation tolerance of EEE parts and their packages.***



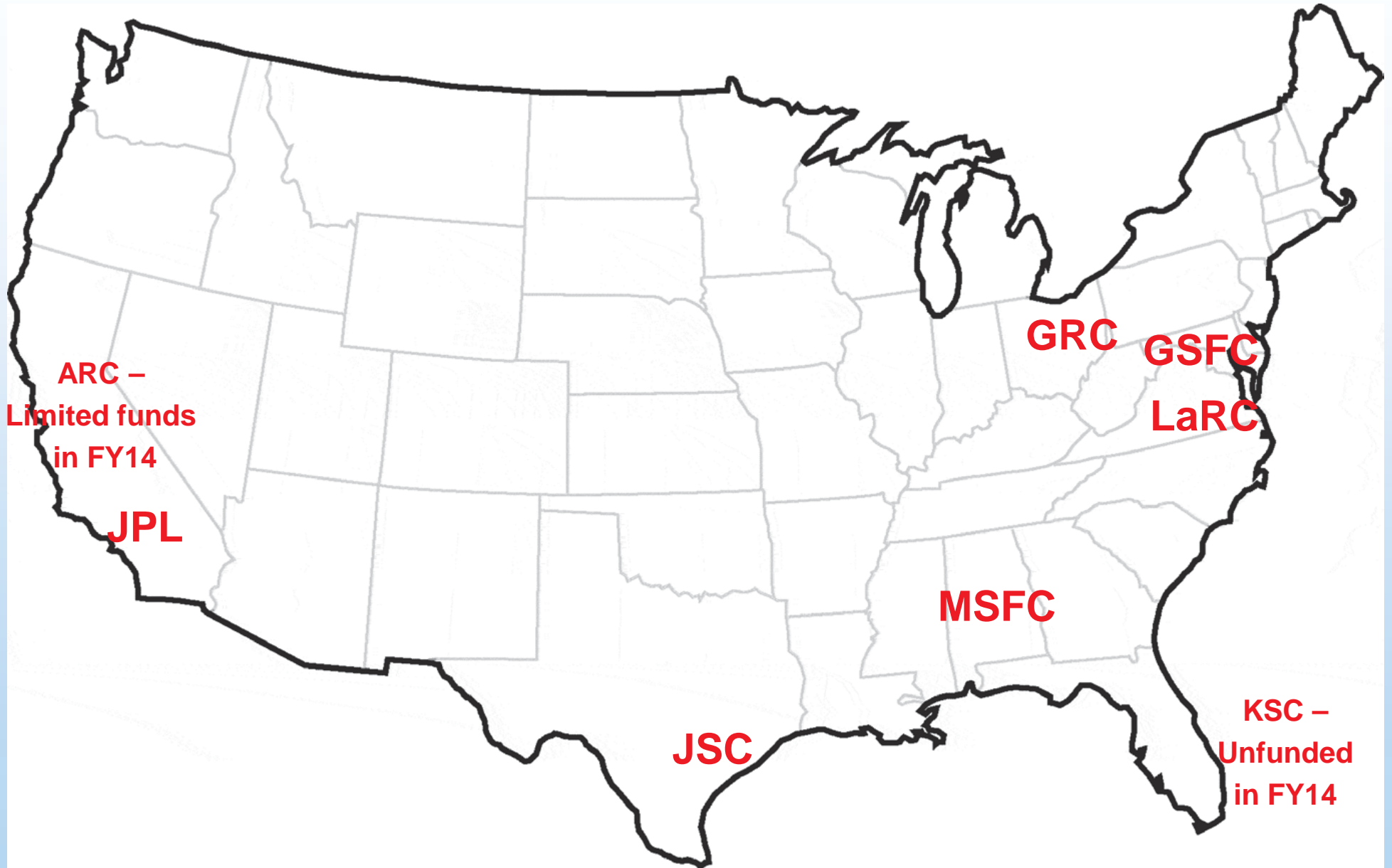
# Notional NEPP View of EEE Parts Needs Diversity







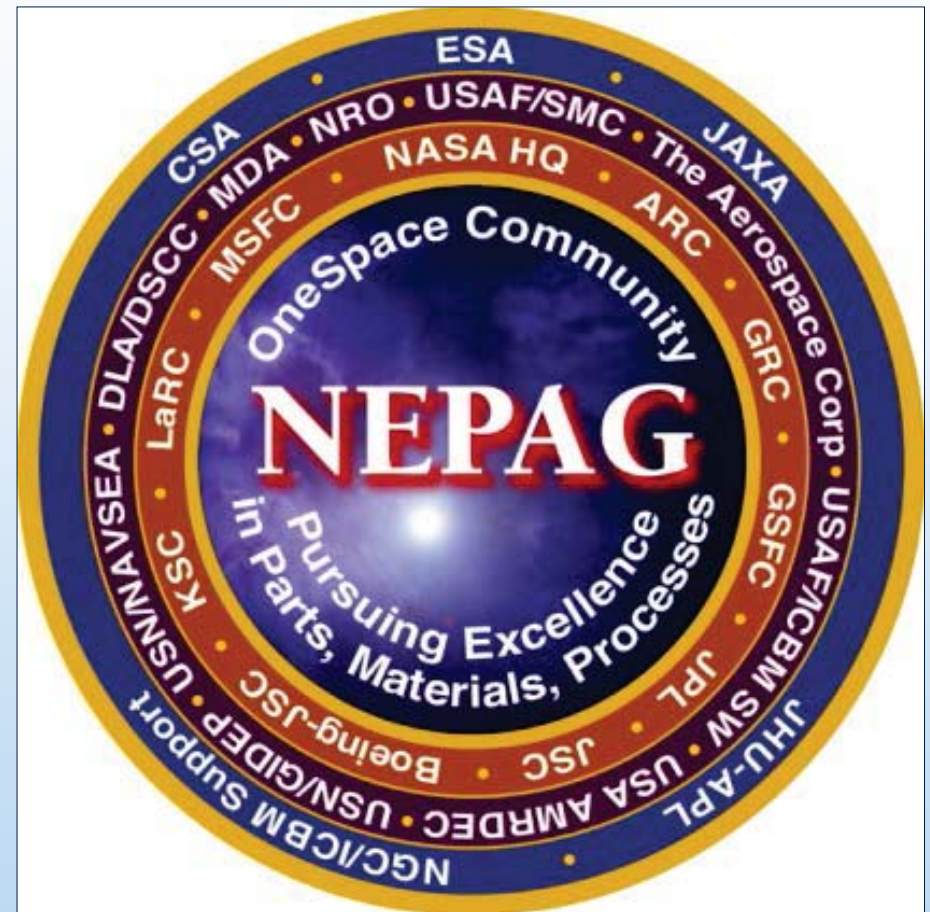
# NEPP at the NASA Centers





# NASA EEE Parts Assurance Group (NEPAG)

- ***Subset of NEPP, formed in 2000.***
- **Weekly telecons,**
  - Typical participation ~25
  - Share knowledge and experience
  - Address failures, requirements, test methods
  - Monthly international
- **Audit support, and**
- **Coordinate specification and standards changes.**





# Sharing NEPP Knowledge

- **NEPP success is based on providing appropriate guidance to NASA flight projects.**
  - Interaction with the aerospace community, other government agencies, universities, and flight projects is critical.
- **NEPP utilizes:**
  - NEPP Website (<http://nepp.nasa.gov>),
  - Annual **Electronics Technology Workshop (ETW)**,
  - **NEW:** EEE Parts for Small Missions, Sep 10-11, 2014,
  - Standards working groups,
  - Telecons (NEPAG weekly and monthly international), and
  - Documents such as Guidelines, Lessons Learned, Bodies of Knowledge (BOKs), and, Technical Papers.



# EEE Parts for Small Missions

- **Meeting Dates: Sep 10-11, 2014.**
- **Location: NASA/GSFC Greenbelt, MD Bldg. 3 auditorium and via web participation. On-site participation will be limited to US/green card participants as well as auditorium capacity.**
- **As a follow-on to an internal NASA EEE parts workshop held in FY13, the NEPP Program will be hosting an open workshop entitled “EEE Parts for Small Missions.” The focus of this workshop is two-fold:**
  - **Provide small mission designers (and new designers) exposure to reliable use of EEE parts in small missions (i.e., “rules of thumb” for parts usage, testing/qualification, and design), and,**
  - **Provide a forum for discussion of recent efforts, plans, and accomplishments. This will include, for example, a discussion on the use of automotive electronics.**
- **While there is not a formal “call for presentations,” we seek participation from industry, universities, and other government agencies. Volunteers are welcome.**



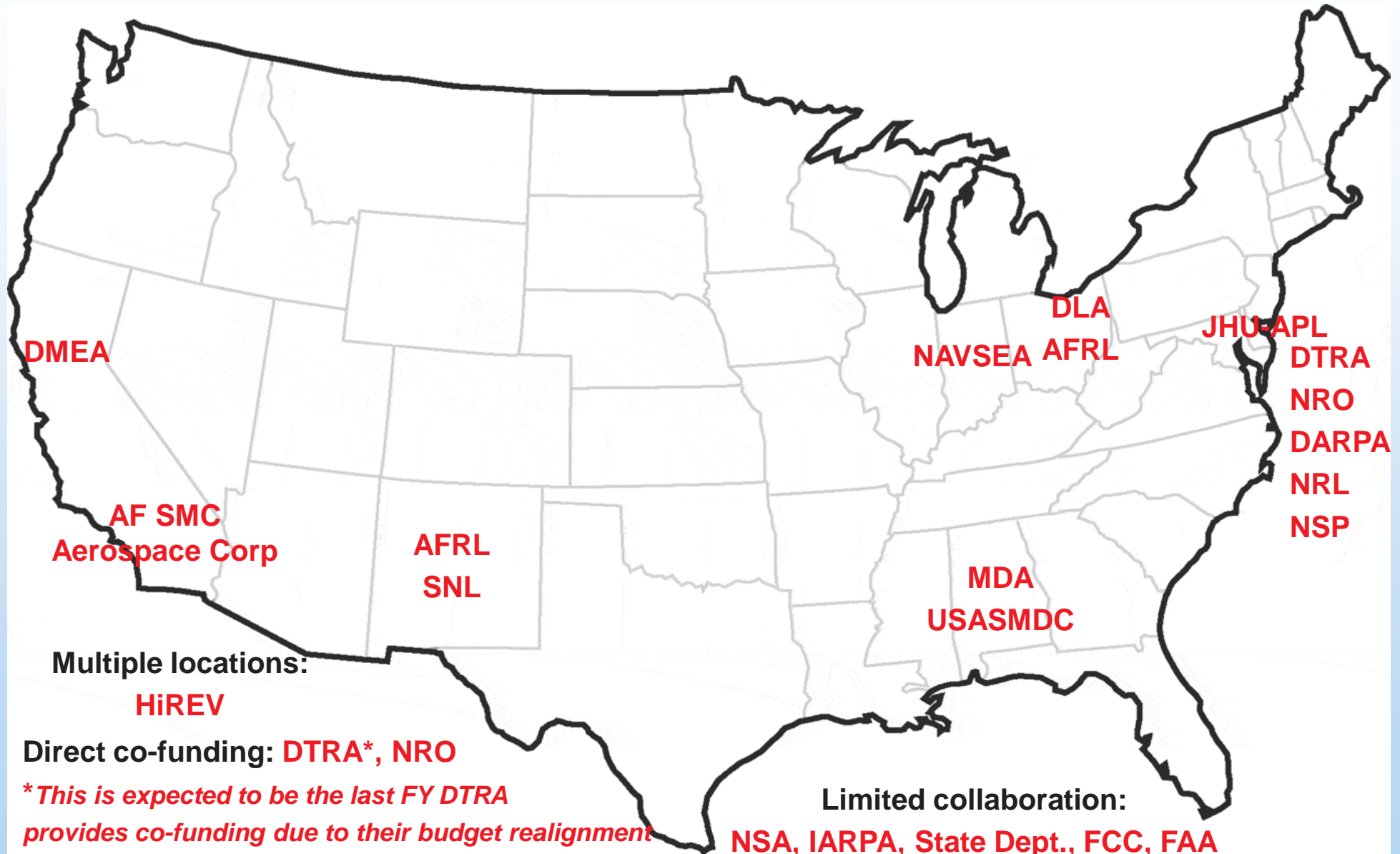
# NEPP Partnerships

- **Collaboration with other U.S. Government Agencies,**
  - Co-funding of radiation effects efforts with Defense Threat Reduction Agency (DTRA) and National Reconnaissance Office (NRO),
  - In-kind efforts and information exchange with DTRA, AFSMC, AFRL, NAVSEA, DMEA, MDA, DARPA, NRL, DLA, USASMDC, SNL, and
    - HiREV is included in this category.
  - We occasionally provide subject matter expertise (SME) to other agencies on point issues (FCC, State Department, IARPA, FAA, and NSA).
- **Information exchange with international space agencies (JAXA, ESA, CNES, and CSA),**
- **Collaboration with industry via in-kind efforts (review, test, samples),**
  - Long list ranging from capacitors to FPGAs
- **Collaboration with universities, and**
  - Currently unfunded due to budget cuts
- **Formal consortia and working group participation.**





# Other U.S. Government Agency Partners – *Information Exchange and In-Kind*





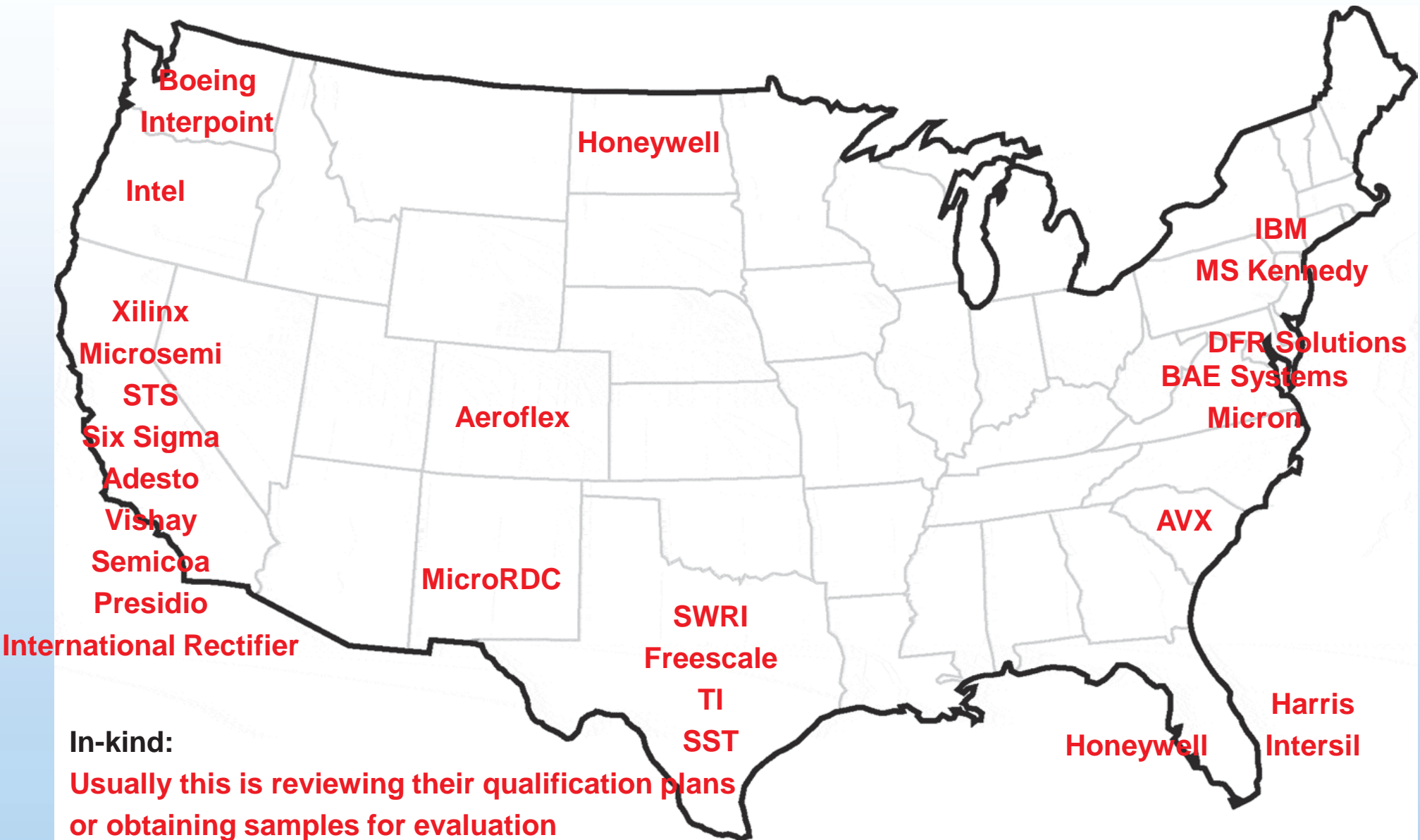
# NEPP – International Agencies

## *Information Exchange Partners*





# Example U.S. Industry Partners – *In-Kind*







## **NEPP: Universities and Consortia – *Budget Cuts Have Impacted Participation***

- **NEPP retains a leadership role in JEDEC and SAE G11/G12 working groups:**
  - Develop standards for qualification.
- **NEPP budget cuts over the last 5 years have reduced NEPP's ability to fund agency participation in consortia:**
  - CAVE (Auburn),
  - CALCE (U of MD), and,
  - AVSI (Aerospace Industry).
- **University research no longer funded at:**
  - Vanderbilt University,
  - Georgia Tech,
  - Auburn,
  - Arizona State University, or
  - University of Maryland.



# How NEPP and HiREV Complement Each Other

## HiREV

- Technology forecasting (US Government needs)
- POF tools for Si and III-V electronics
- Pre-qualification efforts on
  - Base Metal Electrode (BME) Capacitors
  - Class Y packages
  - 45 and 90 nm CMOS trusted foundry technology
- Reliability science
  - GaN technology
- Reliable Electronics
  - Electronic technology Physics of Failure (PoF)
- Radiation Reliability of Electronics
  - Modeling PoF in new technologies

## NEPP

- Body of Knowledge (BOK) documents on new technologies
- Guideline on testing/qualification of FPGAs, memories, BME capacitors
- Evaluation of commercial products
  - BME capacitors
  - GaN/SiC devices
  - FPGAs
  - Automotive-grade electronics
- Reliable Electronics
  - Applying PoF to qualification/usage guidance
- Radiation Reliability
  - Testing for PoF on new Technologies
  - Support modeling/tools on new technologies
  - Qualification/usage guidance

**HiREV utilizes test structures for detailed knowledge (model first).**

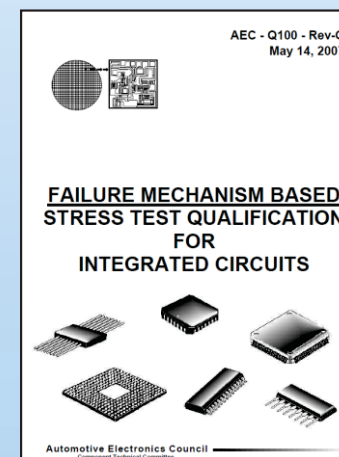
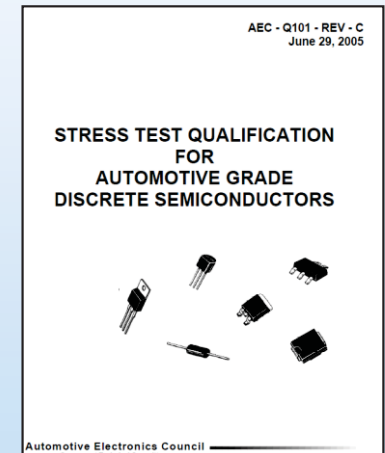
**NEPP utilizes commercial product for general knowledge (test first).**

**HiREV PoF on early TRL's feeds NEPP focus on insertion/qualification.**

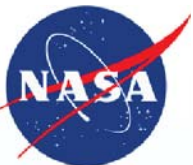


# FY14 - NEPP Evaluation of Automotive Electronic Parts

- Questions to be answered:
  - *What are automotive grade parts, who makes them, what standards exist, and can NASA leverage them for reliable use in space?*
- NEPP objectives:
  - Develop a BOK on automotive grade parts,
  - Test a range of electronic parts (capacitors to transistors to processors), and
  - Develop a guideline for NASA usage.
- Testing will be performed by NASA and NSWC Crane.
- Early results on selected automotive grade capacitors indicate aging/de-aging behavior variance.
  - This behavior could be due to dielectric differences between military-grade parts and the selected test articles (higher volumetric efficiency).

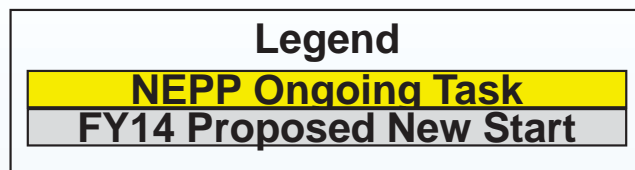


<http://www.aecouncil.com/AECDocuments.html>

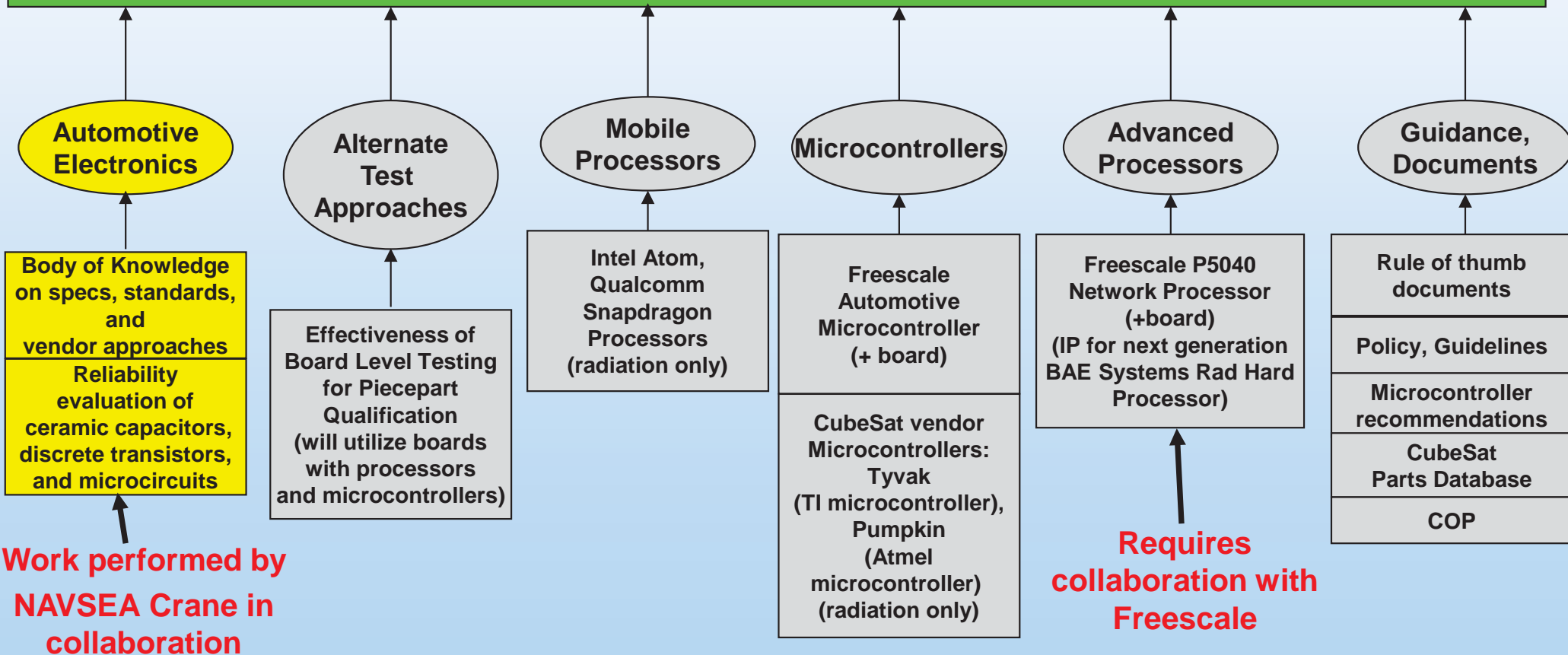


# FY14 NEPP Core – Automotive/Commercial Electronics (Small Missions)

**Core Areas are Bubbles;**  
**Boxes underneath are variable**  
**tasks in each core**



## NEPP Research Category – Automotive/Commercial Electronics





# FY14 NEPP Core - Complex Devices

**Core Areas are Bubbles;**  
**Boxes underneath are variable**  
**tasks in each core**

Legend	
	NEPP Ongoing Task
	FY14 Proposed New Start

## NEPP Research Category – Complex Devices

**FPGAs –  
Radiation**

**Xilinx Virtex 5QV**

**Commercial  
Xilinx 28nm  
Virtex-7, Kintex-7**

**FPGA SOCs  
Xilinx Zynq,  
Microsemi  
SmartFusion 2**

**New Microsemi  
and ATMEL**

**Embedded  
Coldfire™**

**FPGAs –  
Reliability**

**Xilinx Virtex 5QV  
Daisy Chain  
Package  
Evaluation**

**FPGA SOCs  
Xilinx Zynq,  
Microsemi  
SmartFusion 2**

**Area Array  
Packages**

**Class Y QML**

**Class Y and IPC**

**HALT for  
PBGA**

**Thermal Interface  
Materials**

**Solder Bump  
Comparison**

**Flip Chip  
Interconnect**

**Memory  
Devices**

**Resistive Memory  
(RERAM, CBRAM)  
Radiation,  
Reliability**

**3D Structure  
FLASH Memory  
Samsung VNAND  
Radiation,  
Reliability**

**DDR3 Memory  
Radiation,  
Reliability**

**Advanced  
CMOS**

**IBM  
trusted foundry  
14-32 nm  
Radiation**

**Intel  
14 nm  
Radiation**

**DARPA LEAP  
Program  
(32 nm)  
Radiation**

**Assurance**

**Memory Fault  
Coverage**

**SOC  
Radiation**

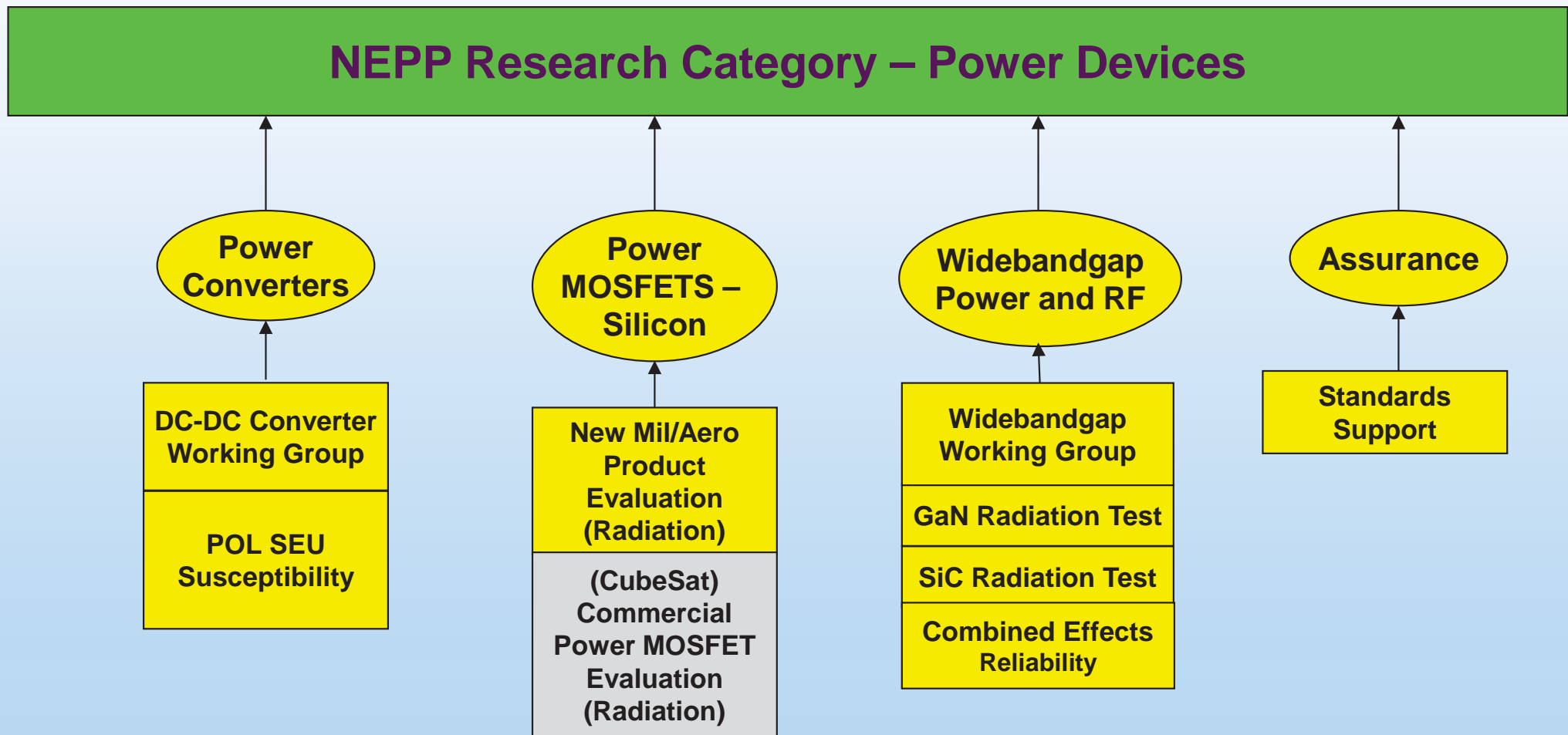
**Synopsys  
TMR Tool  
Evaluation**



# FY14 NEPP Core - Power Devices

**Core Areas are Bubbles;**  
**Boxes underneath are variable**  
**tasks in each core**

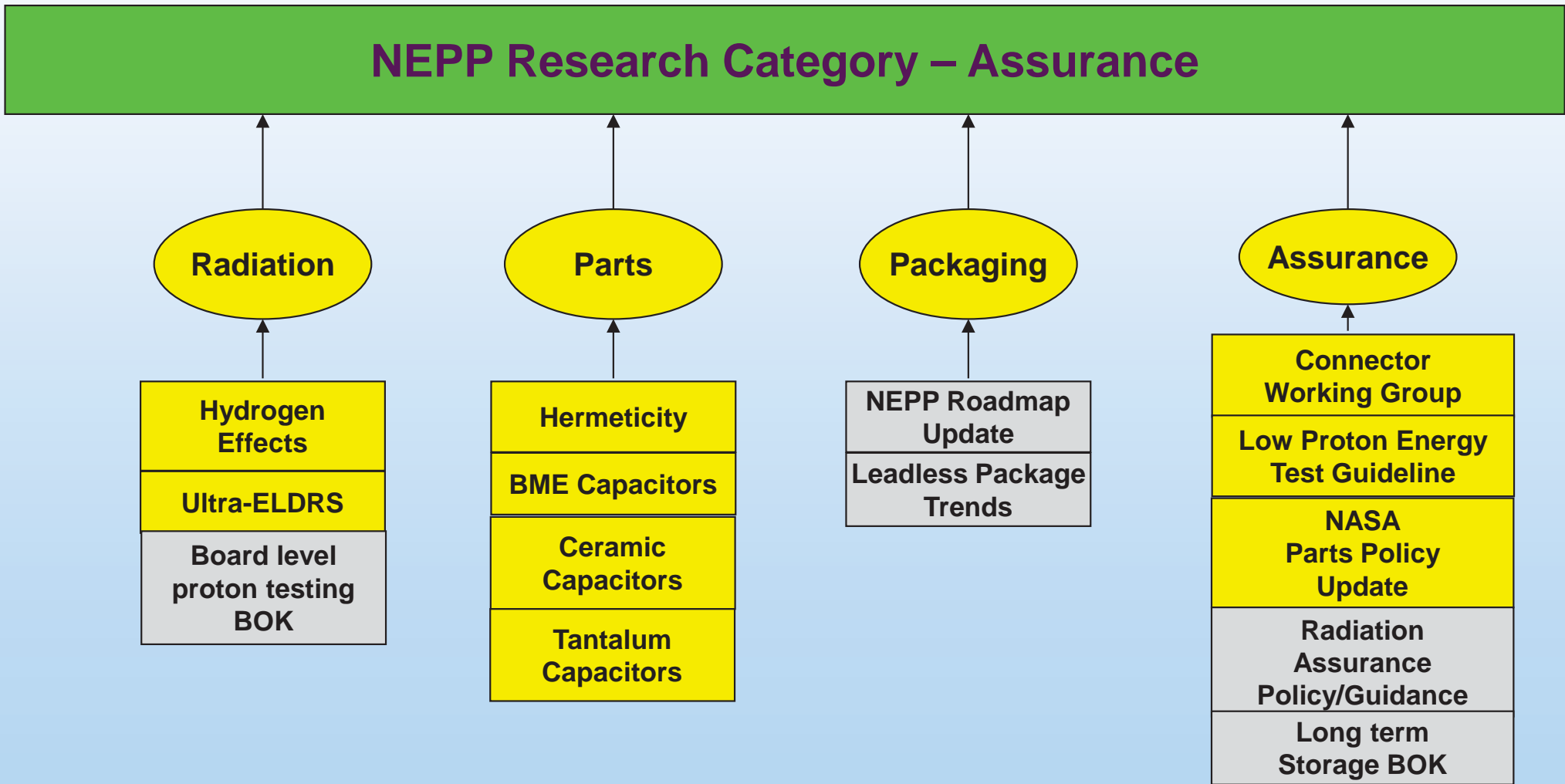
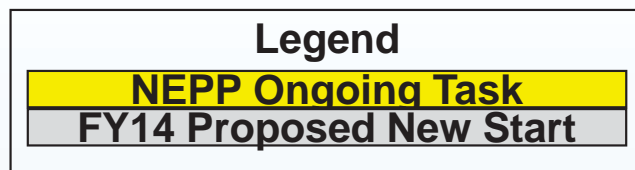
Legend	
	NEPP Ongoing Task
	FY14 Proposed New Start





# FY14 NEPP Core - Assurance

**Core Areas are Bubbles;**  
**Boxes underneath are variable**  
**tasks in each core**



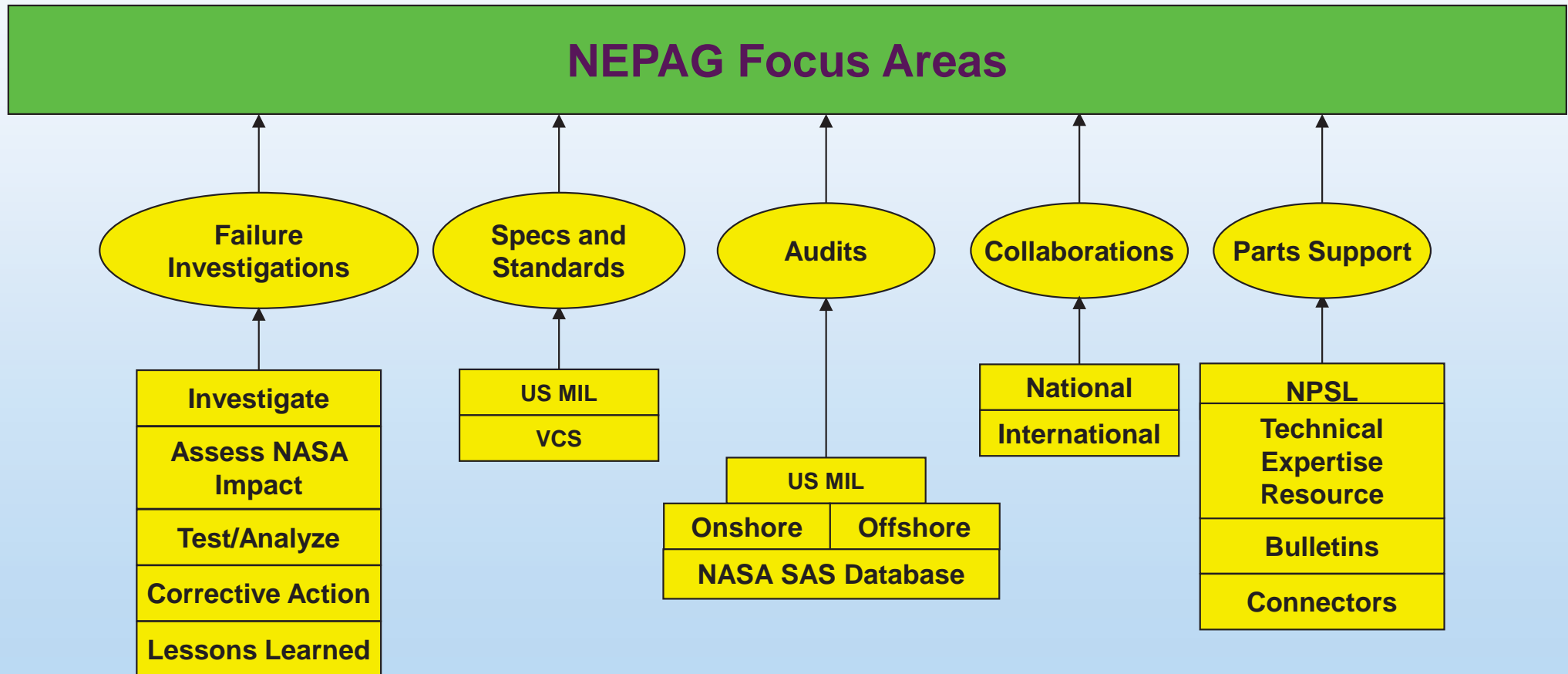




# NASA Electronic Parts Assurance Group (NEPAG)

**Core Areas are Bubbles;**  
**Boxes underneath are**  
**elements in each core**

Legend	
	NEPP Ongoing Task
	FY14 Proposed New Start







# Sample Overguide Task Areas

- **Fiber Optics,**
- **Sensor Technologies (IR, visible, etc...),**
- **SiGe Advanced Mixed Signal,**
- **ADCs/DACs,**
- **GaAs Electronics,**
- **Connector Evaluation,**
- **3D Packages,**
- **Flexible Electronics,**
- **MEMS,**
- **University Research, and**
- **CAVE/CALCE Memberships.**



# Summary

- **NEPP is an agency-wide program that endeavors to provide added-value to the greater aerospace community.**
  - Always looking at the big picture (widest potential space use of evaluated technologies),
  - Never forgetting our partners, and
  - Attempting to do “less with less” (static budget versus rising costs).
- **We invite your feedback and collaboration. Please visit our website (<http://nepp.nasa.gov>).**
- **Join us at our new “EEE Parts for Small Missions Workshop” in September.**
- **Questions?**